Office de la propriété intellectuelle du Canada

Un organisme d'Industrie Canada

Canadian Intellectual Property Office

An Agency of Industry Canada

PCT / CA 00 / 00855

10/030480

10 AUGUST 2000 (10 - 08 - 00)

REC'D 25 AUG 2000

WIPO PCT

Bureau canadien des brevets

Certification

La présente atteste que les documents ci-joints, dont la liste figure ci-dessous, sont des copies authentiques des documents déposés au Bureau des brevets.

Canadian Patent Office

Certification

This is to certify that the documents attached hereto and identified below are true copies of the documents on file in the Patent Office.

Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,277,654,** on July 19, 1999, by **LUXELL TECHNOLOGIES INC.,** assignee of Peter G. Hofstra, David J. Johnson and Olga A. Pershin, for "Electroluminescent Display Packaging and Method Therefor".

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Agent certificateur/Certifying Officer

August 10, 2000

Date

Canada

CIPC 68

OPIC CIPO

interoffice
MEMORANDUM

PROPRIETARY TO

LUXELL TECHNOLOGIES INC

Introduction

It is proposed that Luxell patent the packaging materials and techniques that have been developed for its electroluminescent display technology, in that a number of the materials and techniques employed are unique either in concept or in execution. This includes: the use of a two-part cure gel as the material in contact with the electrode structure; the injection (two hole) techniques used to fill the cavity which contains the gel; procedures relating to sealing the packaged displays, including application and removal of the fill tube to create a planar surface at the back of the display and use of an epoxy putty for sealing; and finally procedures related to moisture bake out prior to packaging, both in vacuum and in air.

Background

El displays, based on ZnS, must be sealed from moisture to have adequate operational life for most applications. The packaging procedures and materials used must seal the module such that no moisture can penetrate from the ambient. The material which is in direct contact with the electrode structure should also act as a heat sink to keep the display at a reasonable temperature and as a passivation medium which can promote self-healing. Ideally this material would initially be in a liquid state to promote easy filling of a cavity behind the EL display but then cure to a soft solid. It would also be dark in colour to increase display contrast and could be a desiccant. To this end, a wide variety of patents exist which describe materials and methods for packaging EL displays.

Most of these are variations on materials and techniques discussed in P/N 4213074 (Thin Film EL Display Panel Sealed by Glass Substrates and the Fabrication Thereof), which describes: the creation of a cavity behind the display with a second piece of glass; the filling of this cavity with a (liquid) silicone oil or grease; and sealing. To fill the cavity the package is prepared by drilling a hole either into the backing glass or into the perimeter seal, inserting a tube and gluing it into place. The end of the tube is then placed into a container of the oil and the two items are stationed in a vacuum chamber. Air is pumped out of the chamber, evacuating the cavity through the oil. When the chamber is brought back up to room pressure the oil flows into the cavity to fill the vacuum that had been formed there. The tube is then crimped to seal the filled cavity and sealed with an epoxy.

Improvements on this process may be broken into two categories. Changes in the materials used to fill the cavity have included:

1. The introduction of a moisture absorbing member into the oil (P/N 4357557, Glass Sealed TFEL Display Panel Free of Moisture and the Fabrication Method Thereof). This is designed to ensure a moisture free environment.

2. Use of a heat cured resin added to the oil which cures during the normal operation of the display (4802873, Method of Encapsulating TFEL Panels with a Curable Resin).

3. Using of "perfluorinated inert fluids" as the protective oil, inserted into the cavity either through vacuum techniques or through a two hole injection process (4810931, Fill Fluid for TFEL Display Panels and Method of Filling). This category of liquid has heat transfer and passivation properties similar to silicone oils but is much thinner, allowing for faster fill times.

4. Use of a two part chemical cure gel spread onto the display prior to the application of the second glass substrate and sealing (5194027 Solid Seal for Thin Film Electroluminescent Display Panels). This technique is designed to simplify the packaging process: "filling" is no longer necessary.

Changes in the methods used for filling and sealing have included:

1. A cavity is filled and sealed with solder, specific to LCD's (4037930, Liquid Crystal Display Cells). This should provide a more reliable seal then crimping.

2. Variations on the geometry of the concave backing glass and the position of the fill hole in the system. Aimed at a variety of display cells (443063, Liquid-Injection Passage Structure Contained Within a Display Cell).

3. The crimped and epoxied tube is protected with a hollowed out cover epoxied over it (4447757, Structure of Thin-Film Electroluminescent Display Panel Sealed by Glass Substrates).

4. Filling an EL cavity with oil (or coloured oil) using a tube connected to the glass though concentrically drilled holes to allow the tube to be cut/crimped below the planar surface of the covering glass (4839557, Fill Member for Electroluminescent Display Panels). This patent also suggests an injection fill method using two holes in order to avoid using vacuum.

5. A metal, or solder compatible, washer is glued to the glass concentrically over the hole and solder is used to seal the hole in the washer once the display is filled. Can be filled with vacuum or two hole injection techniques (5059148, Thin Film Flat Panel Displays and Method of Manufacture). This not only provides a more reliable seal but is the technique is easier to implement than that described in item 1.

Outstanding Problems

As indicated by the previous section the main packaging issues that can be addressed are as follows:

1. Passivation Material. Historically, the standard passivation material has been silicone oil due to it's favourable heat transfer properties and passivation properties. However a concern of many high end customers is the presence of a thin liquid in the display. Deterioration of the package could then lead to leaking of the liquid into the electronics etc. This is also of primary concern in space applications where a small hole could lead to rapid formation of huge forces on the display glass itself. That the fill material is liquid also suggests easier migration of moisture within the material

   Thus effort has been placed on finding a non-liquid material which can be used as the passivation medium. Both gels and resins have been suggested in the patent literature. These materials have been promoted as they are solid enough to not flow under deterioration of the package, but are soft enough to adequately promote self-healing of the solid state display. In general a material of hardness of less than 40 durometers (Shore A hardness) is desired.

   The resin is an additive to the silicone oil which causes it to harden when exposed to the heat of the operating display. The gel has a two part chemical cure but is thick enough in its uncured state so that it can be simply spread onto the display and then packaged. However the disadvantage of this procedure is that it makes difficult the creation of moisture free surfaces.

2. Sealing. The seal that keeps the fill material in the cavity is often the weakest mechanical part of the package and the problem has been addressed by several patents. These include the use of solder to seal the hole, or placing additional mechanical seals over the hole. However, many of these methods result in a back surface which is non-planar as the solutions define a rather large bump where the tube hole is covered. Finally, most of these methods necessitate a portion of the fill tube being left behind as it is inserted directly into a hole.

   Certain methods of creating a planar surface (e.g. P/N 4839557, Fill Member for Electroluminescent Display Panels) result in weak points in the already thin backing glass and are not recommended

Present Invention

The packaging techniques developed at Luxell constitute a unique solution to many of the issues described above. These are as follows:

1. Fill material. Luxell uses both coloured gel (black), silicone oil and coloured silicone oil (black). While gel has been previously mentioned in the patent literature this was specifically with respect to spreading it onto an unpackaged display, and adding a glass substrate after the fact. Thus most of the mechanical packaging is implemented afterward. Unfortunately this exposes the internal surfaces to ambient moisture for longer than necessary. Luxell forms the cavity prior to filling, as with the silicone oil, but fills the display with gel using a two hole injection technique. The gel cures to a solid after filling. This technique is unique in the literature. Heat processing of the package (see item 2. below) occurs immediately prior to filling

   The black colouring agent used in the gel is also unique in the literature. The colouring of the fill material improves the contrast of the display and reduces package assembly time as prior to this technique the backing glass was darkened using a labour intensive painting technique. The colouring agent, which should be a non-conducting inorganic or organic material, also improves the thermal conductivity of the gel. It would also be possible at this point to include a desiccant agent in the colouring, or preferably a colouring agent which is inherently a desiccant. This idea ism unique in the literature.

   Use of the gel also precludes the necessity of using the vacuum fill technique. Indeed it is difficult to use vacuum techniques with the gel as cure times are less than the pump down time required to reach an adequate vacuum in the cavity. Thus a two-hole fill technique is employed with the mixed gel being outgassed for 10 minutes under low vacuum prior to filling.

2. Moisture Management. Moisture management is crucial to the lifetime of the display. Previous packaging techniques have dealt with this by heating the fill material and by placing desiccants into the display cavity itself. This does not directly address surface moisture present on the internal surfaces of the cavity and indeed is not recommended with the two-part gel material. Luxell handles this issue by subjecting the whole package to a bake or vacuum bake prior to filling. This is unique with respect to both gel and oil.

   In the case of a vacuum oil-fill the displays are placed in a vacuum oven thus accomplishing simultaneous outgassing and cavity evacuation. Outgassing temperature is also lowered. This technique is unique in the literature. Finally it is suggested that the oil be filtered through a desiccant material prior to filling to remove moisture. This is also unique in the literature.

3. Tube. Filling the cavity with a liquid requires a tube attached to the hole in the cavity. Normally this was done by insertion of the tube in the hole and crimping. A portion of the (plastic or metal) tube is left behind resulting in a perhaps thermally non-compatible material in contact with glass, as well as a non-planar back surface. In Luxell's case extreme thermal cycling is critical to the product. The tube is thus epoxied only to the surface of the backing glass and once the cavity is filled and sealed (see next item) the tube may be cut off completely from the package. This is unique in the literature.

4. Sealing. Sealing the hole has previously been accomplished by crimping the tube or soldering the hole. To allow for removal of the tube and for a relatively planar back surface neither of these techniques are suitable. Luxell has thus discovered that sealing the hole though the insertion of a plug down the tube is most effective. This plug material must be soft enough to expand to fill the hole, yet thick enough so that it can be moved down the hole with a suitable rod. Ideally it must be dark in colour such that it cannot be noticed when looking through the front of the display, and non-conducting in case it comes into contact with the electrode structure through pinholes in the packaging dielectric. It should also be non-reactive with the passivation material and preferably harden so as to not risk breaking up under vibration tests. Various commercial epoxy putties fit this description exactly and thus Luxell uses these materials to seal the hole prior to tube removal. This is unique in the literature.

5. Applicability. Note that application of the above described packaging techniques and methods can also be applied to EL displays based on a wide variety of phosphors, not just ZnS. This can include not only all possible inorganic phosphors (e.g. CdS, ZnSe, SrS, etc.) but also devices based organic electroluminescent materials.

Conclusions

To the best of our knowledge what is unique to our materials and methods is the following:

1. Use of a coloured gel as the packaging material.
2. Use of a coloured gel which incorporates a desiccant material either on its own or as a couring agent which is also a desiccant.
3. Placing the gel into the cavity using a two-hole injection technique.
4. Baking out the display package prior to filling to remove surface moisture.
5. Baking out the display package in a vacuum prior to filling to remove surface moisture.
6. Filtering the fill material through a desiccant prior to filling.
7. Attaching the fill tube only to the surface of the backing glass and complete removal after filling.
8. Use of an epoxy putty to seal the fill hole.
9. Application of these techniques to organic as well as inorganic phosphors.

LUXELL Technologies Inc.	PRODUCTION INSTRUCTION	No. PI0106	Rev. N/C	Page 1 of 8

Gel Packaging

Prepared By:	Approved By:	Approved By:	Approved By:
R. Parks & M. McCullough	C. Dickson	R. Ruta	P. Bajcar
Date: AUG 20/98	Date:	Date:	Date:

REVISIONS

Rev.	ECN	Change date	Description	Approval
N/C		AUG 20/98	New Procedure	

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

Table of Contents

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

	SPECALTITY TOOLS	
	Wire Rack	
	1500 XL Epoxy Dispenser set to 5 PSI	
	3 CC Barrel and tip number 52080-1	

Table 1

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

General Notes:

1. ESD precautions and control shall be observed at all times.
2. When handling chemicals, protective eye wear and hand protection must be worn at all times. Other necessary safety precautions shall be in accordance with WHMIS MSDS sheets.
3. Manufacturing area practices shall be in accordance with SSP.
4. Each operator shall be responsible for the general condition of equipment and house cleaning.
5. Electrical component mounting and soldering criteria shall be in accordance with SSP.
6. The cleaning of hand soldering flux residues shall be done per SSP.
7. Hand tool usage and maintenance shall be in accordance with SSP.
8. Ensure that no material is used beyond its designated shelf life.
9. Ensure that all equipment requiring calibration has a valid calibration sticker prior to use.
10. Operators are responsible for ensuring the quality of their work.

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

STEP 10 ISSUE KIT

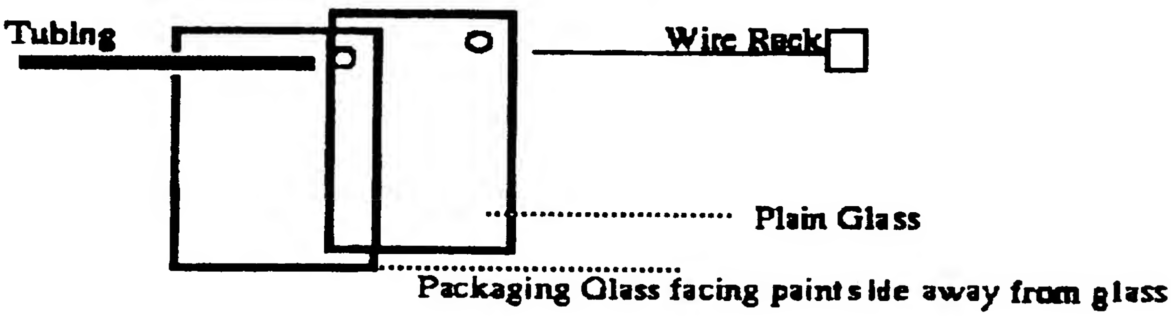
10.1 Issue kit to production floor.

STEP 20 INSPECT GLASS

20.1 Using a microscope visually inspect the substrate glass for aluminium process shorts between rows.
20.2 With a sharp, clean razor blade remove any identified shorts.
20.3 Short the row electrodes along the edges of the glass with a shorting bar. Measure the resistance across the glass and record the value on the traveller.

STEP 30 INSTALL TUBING

Note: **UV Goggles <u>Must</u> be worn during this operation**
Note: **Backing glass must have holes drilled in two opposite corners**
30.1 Turn the light welder on.
30.2 Place a clean, plain piece of glass in a tray. Place the packaging glass on top. Insert a wire stand through the hole in the two pieces of glass. Slide a 3" piece of tubing (Luxell P/N 5205) over the wire stand. Hold the tube with one hand to ensure it remains flat on the packaging glass surface. Apply a small amount of epoxy along the joint of the tube and the packaging glass surface (see Figure 1). Repeat on diagonal corner.



30.3 Place the tray in the Light Welder (UV) for a minimum of 30 seconds then remove it from the welder.
30.4 Carefully turn the stand in both directions to dislodge it from the epoxy and remove it from the glass. Ensure the hole in the glass and the tubing are properly aligned. **There must be <u>NO</u> epoxy inside the hole or the tubing.**
30.5 Apply a thin fillet of epoxy around the tubing, ensuring a continuous thin film of epoxy. Verify the tubing is properly attached to the glass.
30.6 Place the tray in the Light Welder (UV) for a minimum of 30 seconds then remove it. Turn off the UV Light Welder.

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

STEP 40 TAPE GLASS

40.1 Prepare glass for taping. Prime packaging glass and substrate using Primer 94 (Luxell Part number 5178-1). Allow a minimum of five (5) minutes for drying.

40.2 Ensure tape is clean and straight. Apply a line of tape to the glass no wider than 0.0625" (1.59mm). trim the tape on a clean surface using a stainless steel knife. Ensure there are no lumps of adhesive on the tape. Clean both the glass and substrate using compressed nitrogen. Apply tape to the glass as shown in figure 2.

STEP 50 PACKAGING GLASS TO SUBSTRATE

Note: Wrist straps must be worn at all times when handling the substrate.

Remember to note the serial number on the correct side of the substrate as indicated on it's container.

Wear UV goggles when the UV Light Welder is in use.

Wear gloves and activate the exhaust fan while using epoxy.

50.1 Peel off the tape covering and apply a thin film of primer to the tape surface. Allow to dry for five (5) minutes.

50.2 Align the packaging glass to the substrate. Ensure that the tubing is in the top corner and does not interfere with the substrate surface. Using a thumb, press down around the glass edges firmly but gently to ensure the glass is fully attached.

50.3 Turn on the UV Light Welder. Apply a uniform bead of epoxy around the edge of the packaging glass to cover the adhesive. The epoxy bead shall be no wider than 0.050" (1.27mm) and shall rise up the side of the packaging glass to cover the tape as a minimum and not rise above the top of the glass as a maximum. While dispensing the epoxy the applicator needle should not be allowed to contact the substrate. Excess epoxy may be trimmed using a clean razor.

50.4 Place the packaged glass flat in the UV Light Welder for at least 2 minutes. Remove the glass and turn off the UV Light Welder.

50.5 Clean the glass using Isopropyl Alcohol (Luxell P/N 5097-1).

50.6 Inspect the epoxy bead for uniformity and good adhesion.

STEP 60 Q. A. INSPECTION

60.1 Inspect the epoxy bead. Verify the epoxy rises above the bottom edge of the glass and does not rise to cover the top of the packaging glass. Verify there are no pin holes along any epoxy fillets. Using a back light verify no light leaks through the painted surface into the active area of the substrate.

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

60.2 Note the glass serial number on the traveller, enter the data into the Q.A. database, and stamp the traveller for pre-fill inspection.

STEP 65 PREPARE EPOXY

65.1 Weigh a portion of RTV6166A gel into a beaker, the quantity depends on the number of displays being packaged, a 1 cc sample of Part A will end up filling one 3x3 display.

65.2 Pour the same amount of RTV6166B gel into the beaker.

65.3 The amount of the blackening component, LIMBK1, is 6% of the total mass of the clear silicone. Add the appropriate mass of the blackening component to the clear silicone and mix thoroughly, approximately 50 strokes with a glass stir rod.

STEP 70 DEGAS GLASS & GEL

70.1 Turn the black knob on the desiccator unit to 'VENT', venting the unit until it opens.

70.2 Place the displays and gel into the desicator.

70.3 Close the door and turn the venting valve to 'PUMP'. Open the rough-in vacuum and turn on the vacuum. Hold the door shut until a vacuum seal is made.

70.4 Leave the glass and epoxy in the vacuum chamber for 15 minutes.

70.5 Vent the desicator with nitrogen then remove glass and gel.

STEP 80 EPOXY FILLING AND PACKAGE FINISHING

80.1 Fill a syringe with gel and start to fill the glass through one tube. The fill rate should be a maximum of 1 cc per 30 seconds. Tip the display up on the corner that is being used to fill such that the second tube where the air is escaping is the highest point on the display.

80.2 When the gel is approaching the corners of the display stop filling for one minute and allow the gel to settle. After the corners are filled with gel resume filling with more gel from the syringe. Fill the display with gel until the top tube is full.

80.3 Allow the gel to cure for 2 hours.

80.4 Insert a small (0.0625" to 0.125" [1.58mm to 3.18mm]) piece of indium wire into the tube. Using a wire rack press down firmly to ensure it is flattened to the glass surface sealing the hole.

80.5 Cut the tubing flush with the packaging glass and clean the top of the hole. Apply a drop of epoxy around the hole to prevent leakage. Cover the epoxy with a small piece of cover glass and apply an epoxy bead around and over the glass. Place the packaged glass in the UV Light Welder for 2 minutes minimum.

80.6 Clean excess epoxy from the back of the glass using a clean razor blade. Inspect the glass to ensure there is no epoxy within 0.160" (4.06mm) of the edge of the substrate edges where bonding fingers are present. Clean any excess epoxy as above.

80.7 Clean glass using Isopropyl Alcohol (Luxell P/N 5097-1) to remove excess gel. Inspect for light or gel leakage.

STEP 90 Q.A. POST FILL INSPECTION

90.1 Inspect glass for gel leakage and insufficient fill.

STEP 100 COLUMN SHORTS TEST

100.1 Using a DMM measure column resistance to adjacent columns. Record any readings below 5K ohms. Hold any glass with identified shorts for Production Engineering evaluation of the fault.

STEP 110 Q.A. FINAL INSPECTION

Luxell Technologies Inc.	PRODUCTION INSTRUCTION	No.: PI0106
Gel Packaging		Rev.: N/C

110.1 Verify the glass serial number is located on the back of the black packaging glass. Verify, using a backlight, that there is no light leakage through the packaging glass into the active area of the substrate. Inspect the epoxy bead for signs of oil leakage. Verify there are no air voids in the packaging oil. Verify all operations have been completed and signed. If acceptable, stamp the traveller and the AMT. Forward glass for bonding.

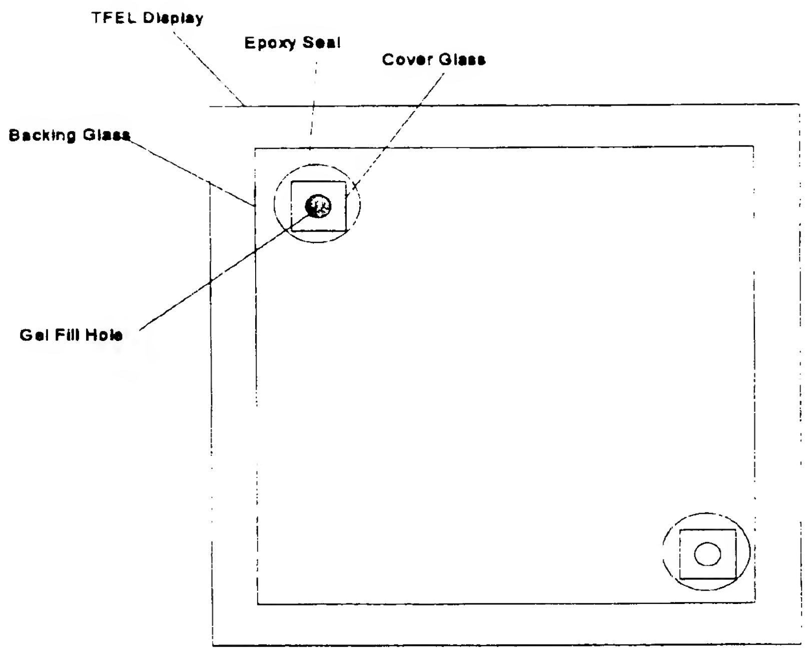

TFEL Display
Epoxy Seal
Cover Glass
Backing Glass
Gel Fill Hole

Fig. A

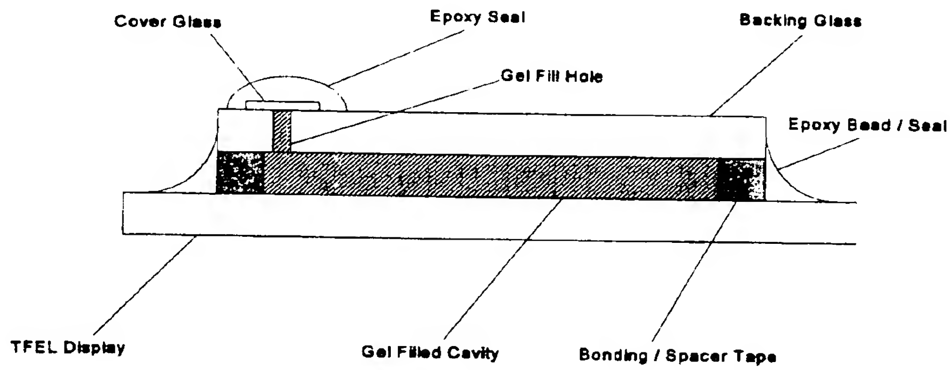

Cover Glass
Epoxy Seal
Backing Glass
Gel Fill Hole
Epoxy Bead / Seal
TFEL Display
Gel Filled Cavity
Bonding / Spacer Tape

Fig. B